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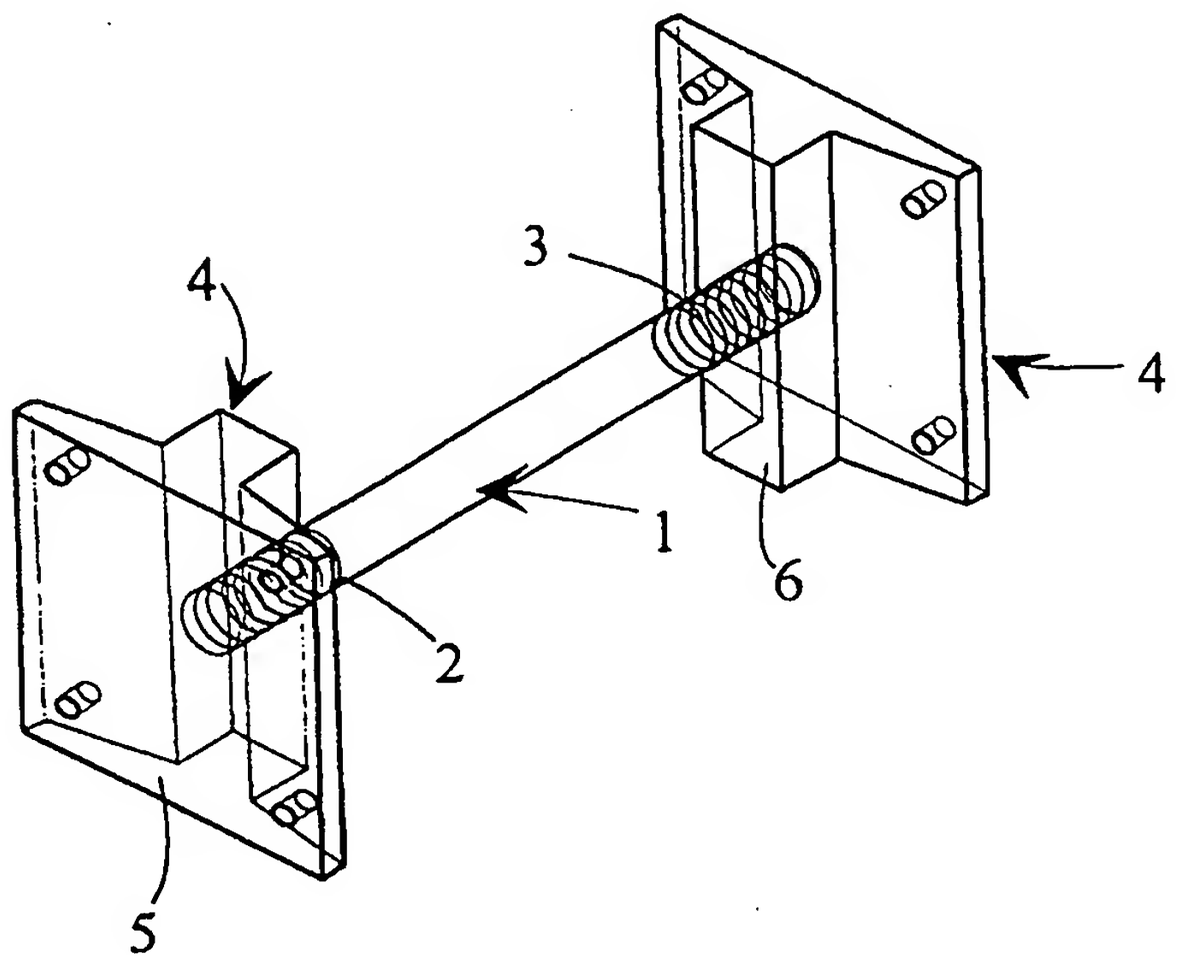
(57) Abstract

A heat exhanger is disclosed comprising a heat pipe (1) having at its end an attachment part (2, 4; 3, 4) the length of which is adjustable. Thus the length of the whole heat exhanger can be adjusted and set to an optimal contact at the place of installation. The invention finds utility e.g. in installation cabinets of telecommunications equipment for the transfer of heat from the mounting rack to the walls of the cabinet.



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HEAT EXCHANGER, CABINET FOR TELECOMMUNICATION DEVICES AND METHOD OF COOLING ELECTRONIC DEVICES

Field and background of the invention

The invention relates to heat transfer technology and pertains to a heat pipe type heat exchanger and its use e.g. in the cooling of electronic equipment placed in a closed space. The invention finds particular utility in the cooling of cabinets of telecommunications equipment.

A so-called heat pipe type heat exchanger comprises a sealed tube inside which there is a vacuum and a suitable small amount of liquid, such as water. One end of the tube, when it is in operation, is located at a heat source and the other end at a cooler heat-removing medium the temperature of which is lower than the condensing point of the liquid inside the tube. Thus liquid is vaporized at the warm end of the tube and condensed at the cooler end. Gravity or capillary force causes the condensed liquid to return to the warm end along the wall of the tube. The liquid and the quantity of the liquid are chosen according to the temperature range required. To enhance capillary flow, the inner surface of the tube may be coated with a suitable porous material. The heat transfer capacity of a heat pipe is very high as compared with conventional heat transfer plates or rods of equal size.

U.S. patent document 5,699,227 discloses a heat pipe which has a threaded part at the end placed at the heat source. The threaded part is attached to a correspondingly threaded aperture in the cover plate of an integrated circuit.

General description of the invention

Now it has been invented a heat exchanger according to claim 1. The other claims define advantageous applications of the invention.

A heat exchanger according to the invention comprises a heat pipe at one end of which, at least, there is an adjustable attachment part by means of which the total length of the heat pipe and attachment part can be varied. Through the attachment part heat is transferred from the heat source to the heat pipe or, correspondingly, from the heat pipe to the heat-removing medium. Due to the adjustable attachment part the distance between the heat source and the heat-removing medium may vary within certain limits while using one and the same heat exchanger. Preferably there are adjustable attachment parts at both ends of the tube.

In a preferred embodiment there are different-handed threads and attachment pieces suitable to them at the ends of the tube. Preferably the threads are found on the outer surface of the tube, but they may also be placed on the inner surface of a bushing attached to the end of the tube.

The attachment piece may comprise a heat transfer surface, which is placed against the heat source or heat-removing medium, and which is greater than the cross-sectional area of the heat pipe. The heat transfer surface may be especially cross-directional in relation to the pipe.

The adjustment margin may be e.g. 5 to 40 mm, such as 10 to 20 mm.

Drawings

The accompanying drawings depict heat exchangers according to the invention and their use in the cooling of a telecommunications equipment cabinet.

Fig. 1 shows a heat exchanger.

Fig. 2 shows a second heat exchanger.

Fig. 3 shows a mounting rack and rear wall of a cabinet with a heat exchanger installed therebetween.

Detailed description of an embodiment

The heat exchanger of Fig. 1 includes a straight heat pipe 1 with different-handed threads 2 and 3 on the outer surface of the ends of the pipe. Attachment pieces 4 with counterthreads can be attached to the threads. The distance of the attachment pieces attached to the threads can be altered by turning the heat pipe.

The attachment pieces 4 have a flat bottom 5 by which the pieces can be screwed onto the heat source or cooling medium. On the opposite side of the bottom there is a higher vertical protrusion 6 containing the counterthread. The length of the whole heat exchanger is thus variable.

Various attachment pieces with suitable counterthreads can be attached to the threads 2 and 3 according to need.

Instead of or in addition to screws, two-sided adhesive tape, which conducts heat well, can be used, for example, to attach the attachment pieces 4.

Due to adjustability, the attachment pieces 5 can be brought into a contact as tight as possible with the heat source and the cooling medium. Heat transfer is thus maximal. This way, larger tolerances can be used in the construction and installation of hardware, and one and the same heat exchanger will be suitable for even targets having slightly different nominal dimensions.

The lengths of the threads and counterthreads are determined according to the adjustment margin required, making sure, however, that the coupling always has a heat transfer surface large enough for the application.

The heat exchanger of Fig. 2 has two heat pipes 1.1 with different-handed threads 2 and 3 at the ends of the pipes. The protrusion 6.1 in the attachment piece 4.1 has two parallel holes with counterthreads in oblique orientation relative to the bottom 5.1. Thus the cooling end of the tube can be placed higher than the heating end and the condensed liquid will be returned to the heating end by gravity. The heat pipes further comprise gripping points 7, such as nuts, by which the pipes can be turned. In addition, the attachment pieces comprise vertical cooling fins 8.

Fig. 3 shows a telecommunications equipment rack 9 with a rear wall 10 and side walls 11 between which components are installed and mounted onto the rear wall. When in operation, the components warm up and part of the warmth is transferred to the rack. Heat is evacuated from the components and rack by radiation and conduction. Heat is conducted especially through air and, indeed, the cabinet includes a fan to circulate the air and to enhance the transfer of heat. The temperature allowed inside the cabinet may be e.g. 40 to 75 °C. To provide additional cooling, the rear wall of the mounting rack is connected through a heat exchanger 12 according to Fig. 2 to the rear wall 13 of the surrounding cabinet. In a normal mounting rack it is the rear wall that is the warmest part to which warmth is transferred through contact pins and circuit boards. The walls and frame of the cabinet provide a large cooling area.

By using in the cabinet a heat exchanger according to the invention it is possible to reduce the power needed to circulate the air and, hence, the size of the blower equipment. Due to adjustability, the heat exchanger can be installed in an optimal contact even though the matching tolerances of the cabinet and rack are typically quite large (say, 10 to 20 mm). One and the same heat exchanger can be even used in mounting racks and cabinets of different standards. The size and quantity of the heat exchangers are determined according to the additional cooling power needed.

A suitable heat pipe diameter could be e.g. 5 to 50 mm, length 5 to 30 cm, and heat transfer capacity 5 to 300 W. Cabinet size could be e.g. 50 to 250 cm, depth 15 to 70 cm and height 70 to 250 cm.

Claims

1. A heat exchanger comprising a heat pipe (1) having at one end an attachment part to attach the heat pipe to a heat source and at the other end an attachment part to attach the heat pipe to a heat-removing medium, **characterized** in that the length of at least one attachment part (2, 4/4.1; 3, 4/4.1) of the heat pipe (1) is variable and it can be used to adjust the combined length of the heat pipe and attachment part.

2. The heat exchanger of claim 1, wherein there is an adjustable attachment part (2, 4/4.1; 3, 4/4.1) at both ends of the heat pipe.

3. The heat exchanger of claim 1 or 2, wherein there is a thread (2; 3) at the end of the heat pipe and a counterthread for it on the attachment part (4/4.1; 5/5.1).

4. The heat exchanger of claims 2 and 3, wherein there are different-handed threads (2, 3) at the ends of the heat pipe.

5. The heat exchanger of claim 3 or 4, wherein the thread (2; 3) is located on the outer surface of the end of the heat pipe.

6. The heat exchanger of any one of claims 3 to 5, wherein the attachment piece has a bottom (5/5.1) to be placed against a heat source or heat-removing medium on the other side of which there is a counterthread for the heat pipe thread (2; 3).

7. The heat exchanger of claim 6, wherein the counterthread for the heat pipe thread (2; 3) is oblique in relation to the bottom (5).

8. The heat exchanger of any one of claims 1 to 7, wherein there are a plurality of heat pipes at the ends of which there are common attachment parts (2, 5.1; 3, 5.1).

9. The heat exchanger of any one of claims 1 to 8, wherein the combined length of the heat pipe (1) and attachment parts (2, 4/4.1; 3, 4/4.1) can be varied by 5 to 40 mm, such as 10 to 20 mm.

10. A cabinet containing telecommunications equipment, wherein there is a mounting rack (9) for electronic components as well as walls (13) around the mounting rack, **characterized** in that to transfer heat from the mounting rack (9) to the walls (13) the cabinet contains a heat pipe at one end of which there is an attachment part (2, 4/4.1) to attach the heat pipe to the mounting rack (9), and at the other end of which there is an attachment part (3, 4/4.1) to attach the heat pipe to a

wall (13), and that at least one attachment part (2, 4/4.1; 3, 4/4.1) can be adjusted in order to vary the combined length of the heat pipe and attachment part.

11. The cabinet of claim 10, wherein that end (2, 4/4.1) of the heat pipe which is attached to the mounting rack is lower than that end (3, 4/4.1) which is attached to a wall.

12. A method for cooling electronics equipment located in a closed space, wherein heat is transferred from the electronics equipment to a heat-removing medium through a heat pipe one end of which is attached by means of an attachment part to the electronics equipment and the other end by means of a second attachment part to the heat-removing medium, **characterized** in that a heat pipe is used in which at least one attachment part is adjustable in such a manner that the combined length of the heat pipe and attachment part can be varied.

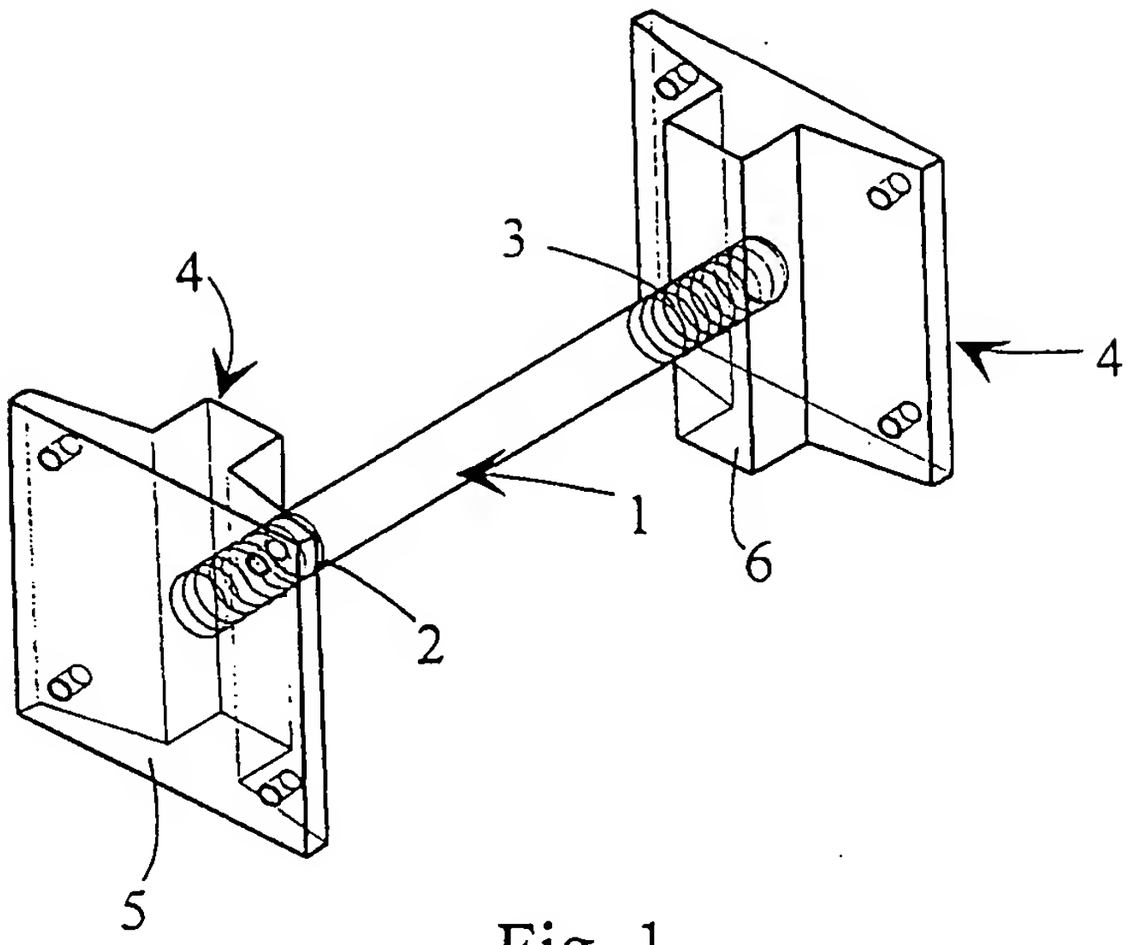

Fig. 1

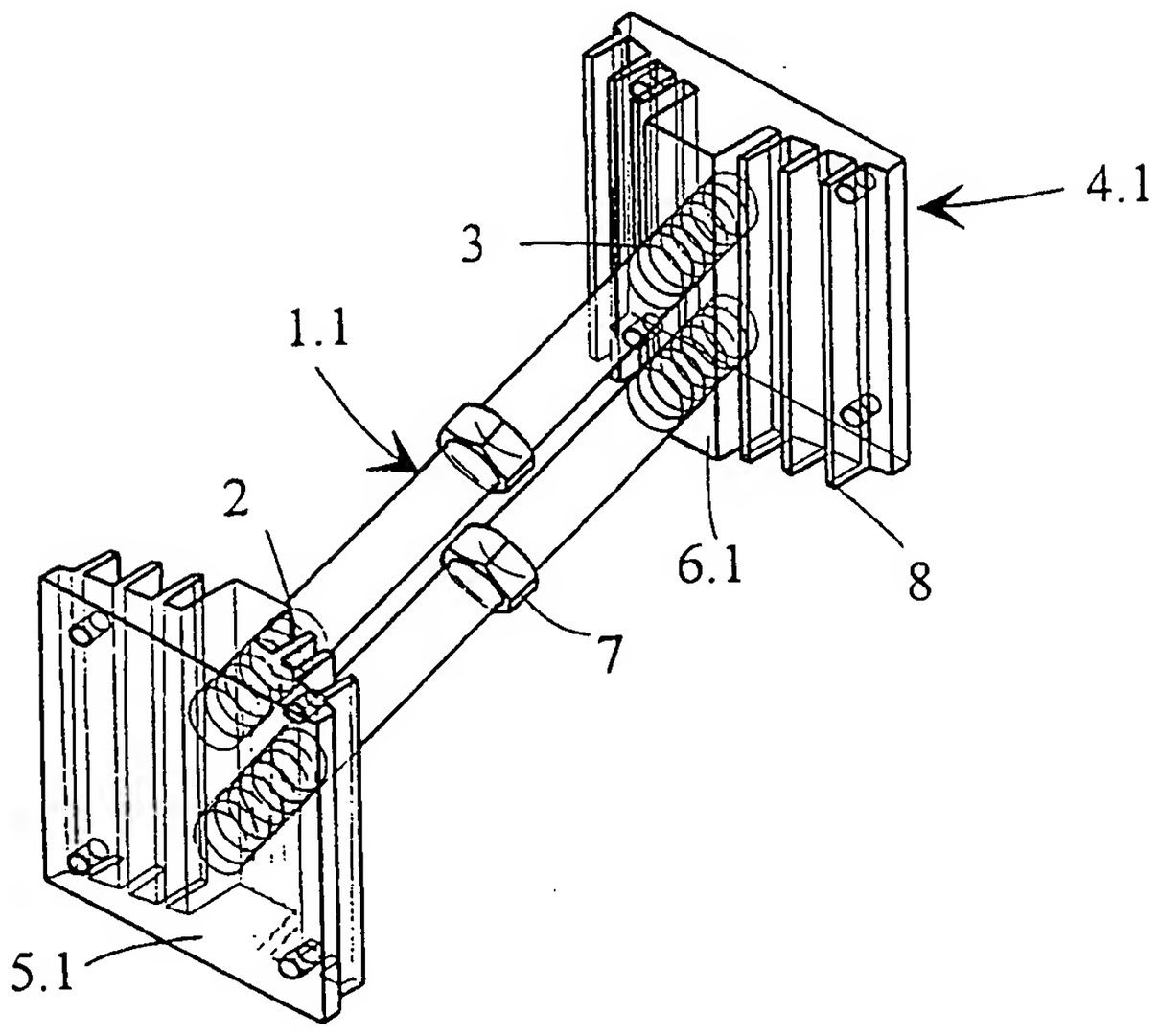

Fig. 2

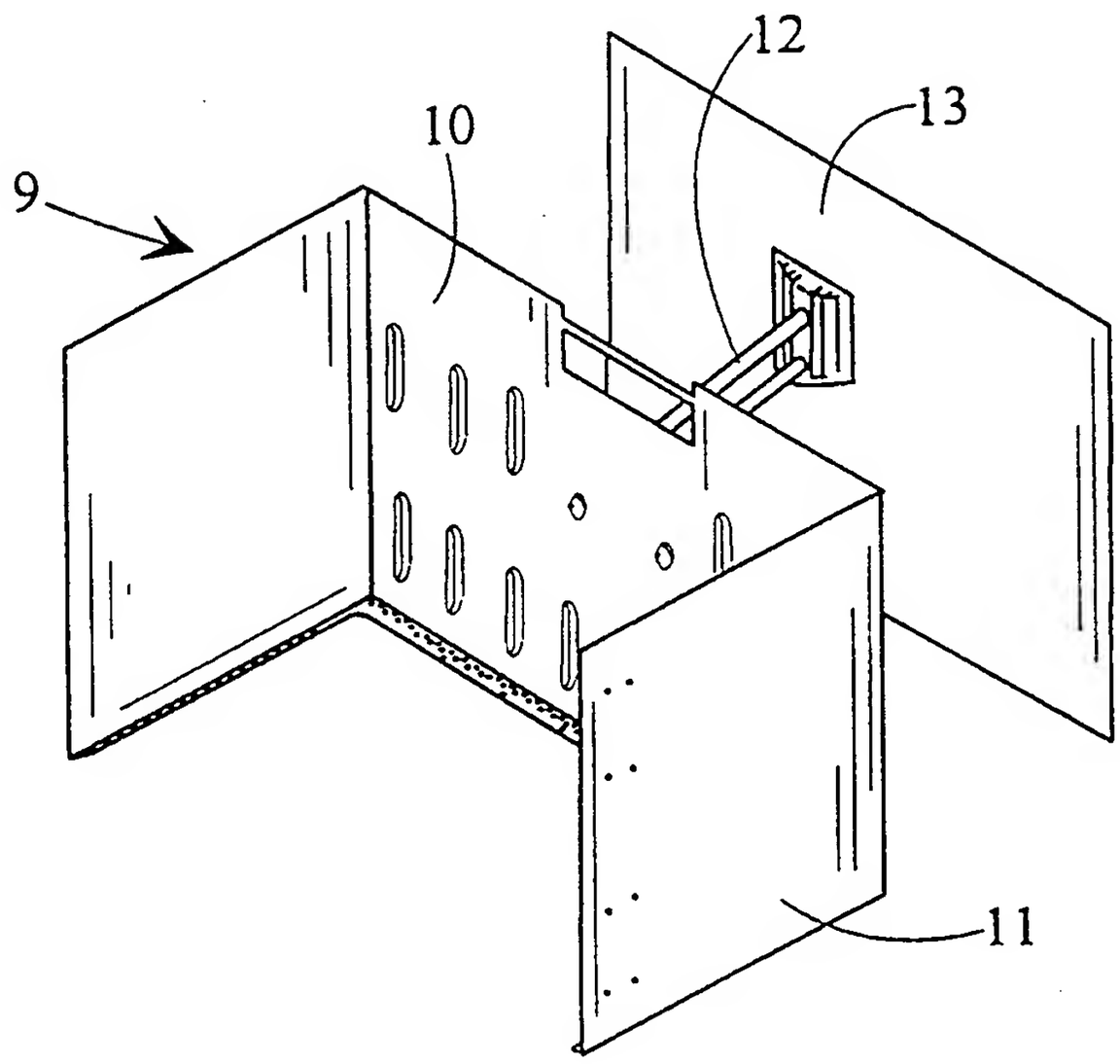

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00719

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F28F 13/00, H02K 7/20, H01L 23/36 // H01L 23/427, F28D 15/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F28F, H01L, H02K, F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4638854 A (NOREN), 27 January 1987 (27.01.87), column 5, line 14 - line 30, see figures --	1-12
X	Patent Abstracts of Japan, abstract of JP 4-366393 A (FUJITSU LTD), 18 December 1992 (18.12.92) --	1
A	EP 0889524 A2 (SUN MICROSYSTEMS, INC.), 7 January 1999 (07.01.99), abstract --	
A	US 5313099 A (TATA ET AL), 17 May 1994 (17.05.94), figure 1 --	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
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